SUBJECT: Review of Voice Operated Devices in Pre-Launch Communications at KSC - Case 900

DATE: October 13, 1969

FROM: J. T. Raleigh

### MEMORANDUM FOR FILE

## INTRODUCTION

The overall pre-launch voice communications are depicted in a set of drawings prepared by KSC. Although not yet complete and to a varying level of detail, these drawings have been very useful in providing an understanding of the total system and as aids in understanding and solving problems which have been experienced. Because voice operated devices (VOX's) have caused problems in several Apollo tests and missions, a careful review of such devices shown on the current drawings has been made.

The drawings show three VOX's in the CSM spacecraft and four "Voice Operated Gain Adjusting Amplifiers" (VOGAA's) in the Goddard Unified S-Band Station whose call code is "GMIL." The drawings do not clearly show the transmit VOX and receive squelch which are incorporated in almost all of the Operational Intercomm System-Radio Frequency (OIS-RF) end instruments and audio interface modems.

Based on a knowledge of the existing procedures and with the benefit of experience, it appears that certain modifications could be made to the voice system to provide more reliable communications. These modifications include the functional removal of the VOX's and certain other changes to provide a reduction in the number of configuration changes that are made during the pre-launch count and provide for more positive isolation of possible noise sources.

The overall KSC diagram (Figure 1) and the two drawings which detail the portions containing the VOX's (Figure 2, GMIL, and Figure 3, spacecraft) are attached. There are four kinds of VOX's in the system -- (1) those inherent in the OIS-RF design, (2) those in the CSM for "hands off convenience," (3) down-link USB System squelch, and (4) up-link keying access. The last has been the source of most of the pre-launch problems and will be discussed first, while the down-link squelch has caused post-launch problems. It should be noted that the figures are from 11 KSC drawings Number FEC/SOAS 10001- 0 1

(NASA-CR-106551) REVIEW OF VOICE OPERATED DEVICES IN PRE-LAUNCH COMMUNICATIONS AT KSC (Bellcomm, Inc.) 14 p

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Unclas 32 11571 It is not the purpose of this memorandum to discuss the overall pre-launch voice system, but only the voice operated switching devices and a suggested reduction or elimination of the troublesome ones.

### UP-LINK ACCESS AND KEYING CONTROL

There are two sets of wires by which KSC can gain access to the radio transmitters at GMIL. One set of lines is identified as "USB" and the other as "VHF" between the Astrocomm Panel in the LCC and the Comm Tech Panel at GMIL. The lines can be used interchangeably as identified on the drawings, but normally one set, the "VHF," is used between GMIL and LCC and both the VHF and USB systems are connected at GMIL to the VHF wires, while the "USB" lines serve as backup. This operational procedure may not provide the most reliable communication between the Astrocomm Panel and GMIL. Because the OIS is implemented without the direct current control logic used at MCC in Houston, the KSC interface at GMIL is different from that of the usual MSFN station for MCC uses Ouindar tones to turn transmitters "on" and "off" and access control. In some modes it is necessary to provide keying; for example, when the A/G communications are simplex, that is between the Astrocomm Panel and GMIL, the same radio frequency is used for up-link and down-link communications.

In the first Astrocomm test from LC 34 to GMIL for Apollo when a VOX-Quindar System from KSC failed to work satisfactorily, GMIL provided a Voice Operated Gain Adjusting Amplifier keying sensor<sup>[1]\*</sup> to operate the VHF transmitter and receiver.

At this point, one must interpret the KSC drawing (Figure 2 attached). Each of the KSC inputs to GMIL has a VOGAA keying sensor VK. The VOGAA recognizes speech and activates the relays Q-1 and Q-2. Each of the MSC inputs to GMIL has a Quindar keying sensor ① which also activates Q-1 and Q-2. Q-1 is a relay controlling the USB up-link access. Q-2 is the control on the VHF transmitter. Q-2 will be discussed first.

<sup>\*</sup>Bracketed numbers refer to the numbered items identified on Figure 2.

In the lower right corner, we have a box identified as "Q-2, VHF-1 or VHF-2, Constant Key." The drawing key identifies Q-2 as a "keying relay which operates from Q or VK through transfer relay for VHF-1 and VHF-2." In fact, Q-2 operates from either voice inputs from KSC or Quindar tones from MCC when the proper transfer keys in the matrix in the lower left of the drawing are selected. The "Constant Key" mode replaces this function by continuously activating the transmitter and providing continuous access of any selected long line and any associated noise to the VHF transmitter.

The "Constant Key" mode of operation was requested by KSC for Apollo 7 and was implemented for Apollo 9 following problems in pre-launch testing. Thus, communications (and OIS noise) through GMIL from KSC is provided continuously to the spacecraft in the same manner as the umbilical on the launch pad. Problems internal to GMIL, such as the Apollo 10 CDDT compression amplifiers and Apollo 11 CDDT VHF transmitter failure, are also noticed by the spacecraft crew.

When the Apollo 9 change to "Constant Key" was accomplished, most people were comfortable that the VOX had been removed from both the VHF and USB up-link. However, there were several experiences in which noise and communications were noticed on the VHF up-link which were not observed on the USB up-link. This was a sympton of some other controlling functions in the S-Band up-link.

The drawings show Q-l in the USB audio up-link and the notes show it to be controlled by Q or VK. Therefore, it can be seen that the USB up-link from KSC is controlled by the same VOGAA keying which proved to be unreliable for controlling the VHF transmitter for Apollo 9. A simplified functional sketch is provided in Figure 4.

This problem area can be alleviated by providing a constant key function for Q-l just as was done for Q-2. This is functionally shown in Figure 5. In this configuration, the need for the VOGAA keying is eliminated.

An even better solution would be to functionally move Q-2 as sketched [X] in the drawing to provide controlled access from Houston over the long lines and to provide a continuous access capability for KSC. This would prevent unwanted long line signals from modulating the transmitter. This problem has occurred in pre-launch testing and the proposed solution is similar to the one being discussed by KSC for controlling the access of the MCC long lines to the basic OIS.

If an audio access realy like Q-l could be provided on the VHF transmitter bus [Y], the long lines noise to the VHF transmitter could also be alleviated. This is functionally shown in Figure 6.

The functions of Q-2 must be retained for the few VHF simplex modes checks made early in pre-launch testing if manual operations and the accompanying procedures are not satisfactory for spacecraft radio system checkout.

As a fall-out of the above configuration change, it would be possible for MSC to perform their communications checks and check their keying without releasing the reliable KSC communication with the crew.

As a digression on the discussion on voice operated devices, but related to the coordination problems which have been experienced in changing the voice configurations, it should be noted that the three bridges in the upper center of Figure 2<sup>[5]</sup> allow MSC to monitor communication to the S/C but KSC cannot monitor MSC communication with the spacecraft. It would seem helpful in coordination if each could hear all the traffic to the spacecraft.

There are standard manual MSFN procedures to backup Quindar failures. In this procedure MCC calls "Apollo 12, Apollo 12 [message] over," and the Comm Tech operates his manual key following the first "Apollo 12" through the "over."

## DOWN-LINK USB SQUELCH

Figure 2 shows that each USB down-link contains a VS or VOGAA squelch. [3] The purpose of this device is to control the noise out of the USB receiver when the USB system or the voice subcarrier is lost. These devices have proved unreliable and since Apollo 10 MSC has asked that they be removed at "Tower Clear," because of the problems demonstrated during the Apollo 9 launch. An A-B comparison (done at MSC) shows words clipped and missing. MSC also requires that both the input and output of the VOGAA be continuously monitored to detect problems with it so that it could be by-passed in the event of trouble. They were only to be used in Apollo 11 when the CSM was in lunar orbit and the LM was on the lunar surface. Note that for Apollo 12, communication links will be changed so that CSM-LM interference will not occur, and this reason for using the VOGAA's is reduced. It should be noted that these methods for removal and monitoring are not clearly shown on the KSC drawings.

There are at least two reasons for removing the VOGAA squelch. One is to reduce the number of real-time configuration changes required at GMIL and the second is to reduce the down-link system sensitivity to changes in spacecraft acoustic noise level such as occurs during cabin purge.

A relatively simple solution to the loss of RF signal problem, if a carrier or subcarrier operated squelch cannot be implemented, is to provide a switch similar to the "Down-link Disable" switch [4] shown for Net 1 and A/G-1 in the USB down-links to KSC Astrocomm. The down-link disable function is shown on Figure 7. It is recognized that the proper adjustment of the squelch is essential. The S/C VHF squelch has been sensitive to EMI noise and the ground VHF receiver squelch has caused problems on Apollo 9 and 10. On Apollo 9 it cut off early and on Apollo 10 it added unwanted noise.

In several countdowns, the period of cabin purge and terminal count RF checks has produced a lot of noise on the OIS. This has, for some reason, been attributed to the VHF down-link receiver (perhaps because of differences in audio clipping level) and changes in the procedures have been made to remove the VHF from the Astrocomm during these periods. Although it is not clear that the VHF down-link should cause the problem as compared to USB or umbilical down-link, the drawings do not show that the VHF down-link (and also the S-Band down-link) can be removed from the Astrocomm System without removing the up-link. Particularly when there are down-link problems, one should not want to unnecessarily penalize the up-link communications configurations.

As presently implemented, the Astrocomm Panel at LCC cannot independently control the up-link and down-link and can only monitor the KSC input and output with GMIL. Therefore, since the down-link disable function exists on some GMIL channels, why not use it on the others which need it?

#### CSM SPACECRAFT VOX's

A VOX was provided in each of the CSM spacecraft audio centers in addition to the "Push-to-Talk" (PTT) mode. This is shown on Figure 3. The continuous spacecraft intercomm with PTT access to the selected down-link (VHF, USB, and/or umbilical) has been the spacecraft mode used in the Apollo pre-launch and launches. As a result of not being used, no problems have been encountered with the CSM VOX.

# BASIC OIS-RF VOX AND SQUELCH

The basic transmitter VOX in each OIS-RF end instrument and audio interface modem is used to control access of the talker into the system. There are possible methods of eliminating this by changing all headset cords with talk capability and all of the end instruments to key on the OIS-RF transmitters manually.

The receive squelch is provided to set a threshold on the amount of noise out of the basic system to either the user's end instrument or modem converting the OIS-RF to audio. As a result, voice is sometimes clipped ("broken-up") or missed. The need for this can only be reviewed based on the total system noise and design parameters. The basic OIS-RF end instrument VOX and squelch can interfere with only one operator's access to the system; the modem VOX and squelch can interfere with the access between the OIS-RF and the audio distribution.

Of major significance in the overall pre-launch testing, the key test leaders do not use their OIS-RF inputs, but rather the audio portion of their OIS end instruments which does not contain any voice operated switches. Thus, there are no VOX's in the KSC audio distribution between the Test Conductor panels and the Astrocomm Panel. For the final critical minutes near launch, the limited access Astrolaunch circuit has no voice operated devices within KSC.

#### CONCLUSIONS

The KSC drawings have been reviewed and discussion has been directed to the voice operated devices. It appears that the dependence on two of the devices can be eliminated, namely:

- 1. Removal of VOX function on the KSC access of the USB up-link at GMIL.
  - a. Relocation of USB access relay function to provide continuous access to the transmitter by KSC inputs and to eliminate continuous long lines access from MCC to the up-link controlled by MCC Quindar.
  - b. Provide a VHF access relay function to provide continuous access to the transmitter by KSC inputs and to eliminate continuous long lines access from MCC to the up-link controlled by MCC Quindar.

- 2. Remove the VOGAA squelch in the USB down-link.
  - a. Consider the implementation of a carrier or subcarrier operated squelch like used in the USB up-link or VHF-AM receivers.
  - b. Provide a "down-link disable" function for VHF and USB to KSC like that provided for MCC on A/G-l and Net l.

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Attachment Figures 1 thru 7

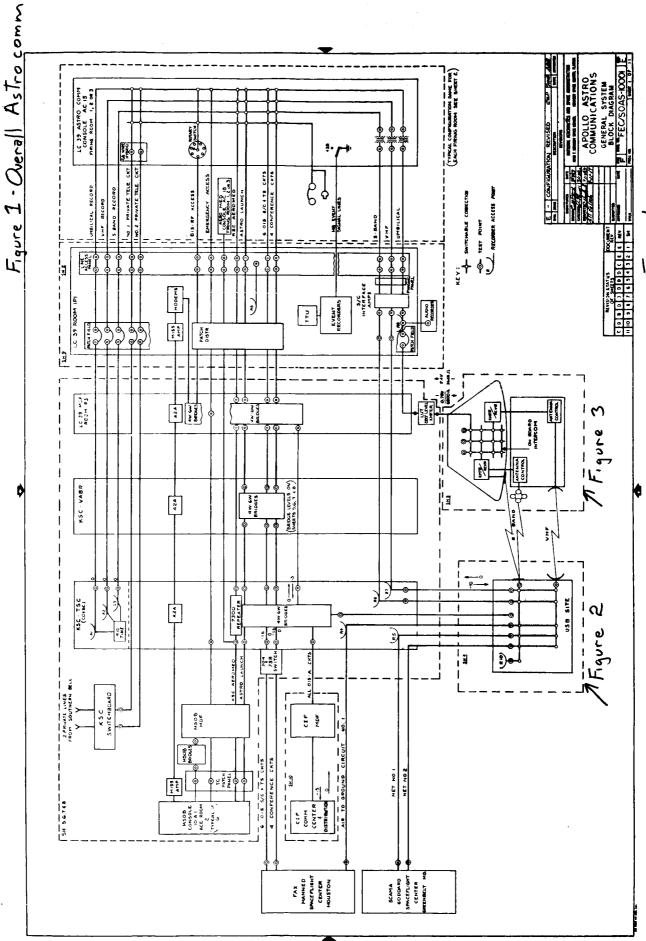


Figure 1

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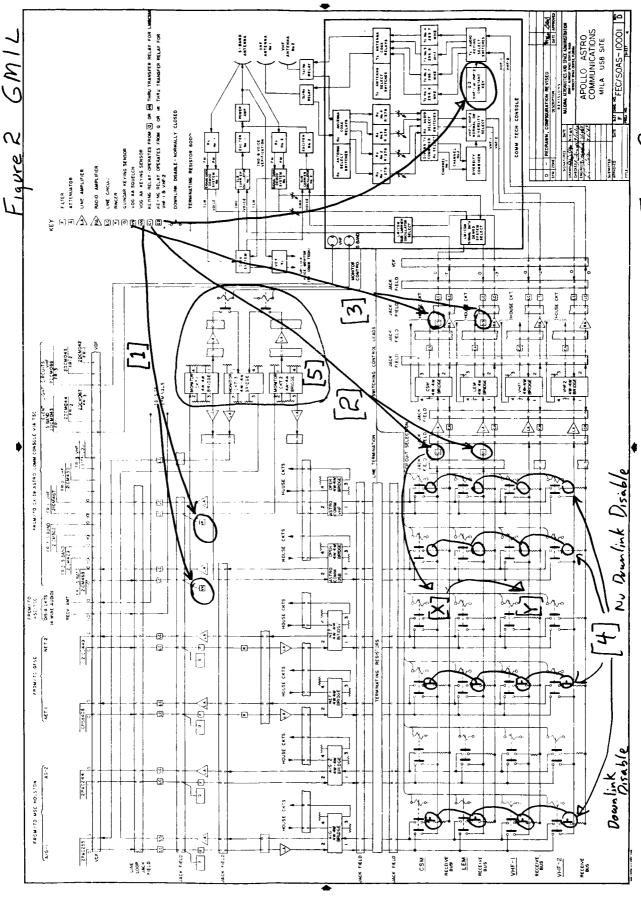


Figure 2

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(·)

Figure 3.

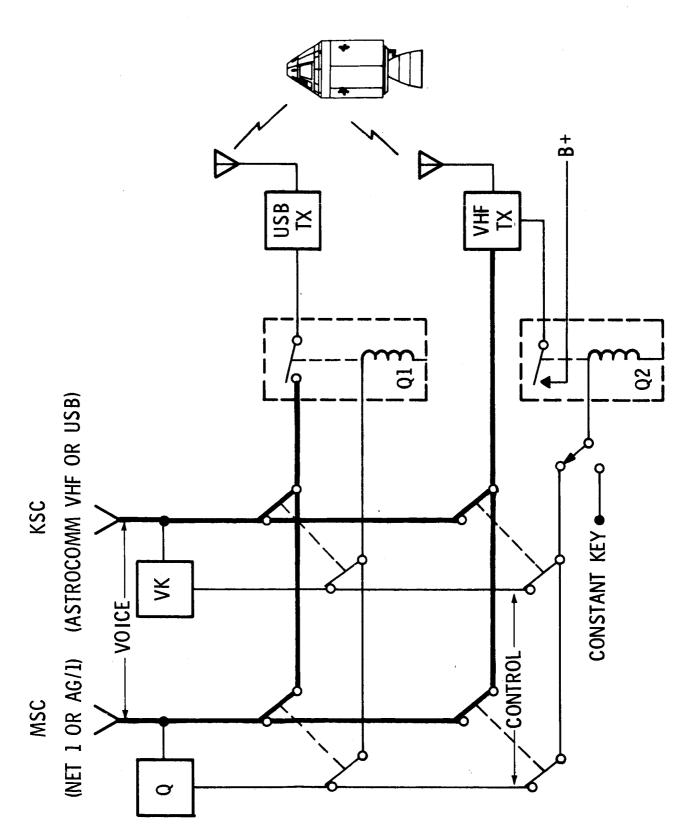


FIGURE 4 PRESENT SIMO UPLINK CONFIGURATION

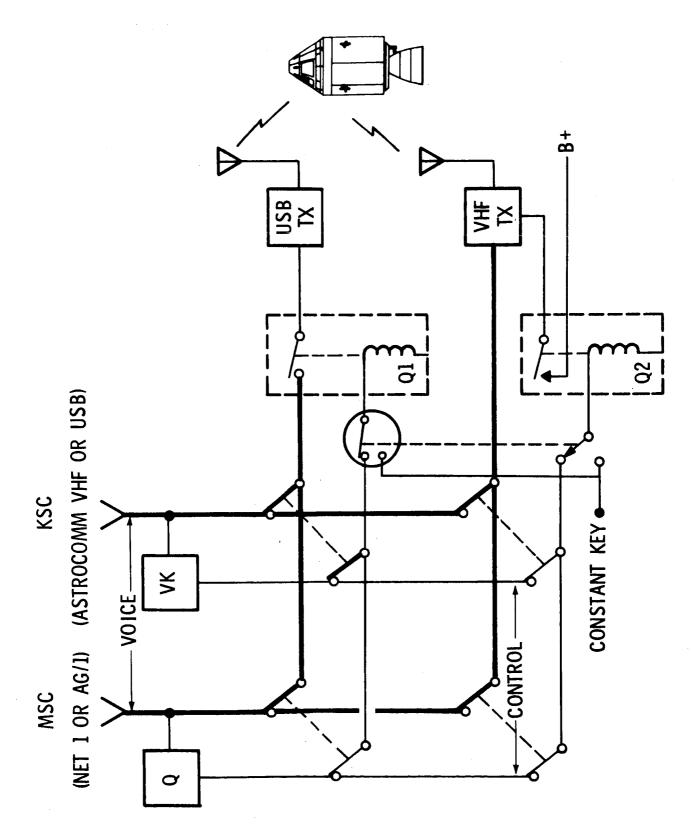
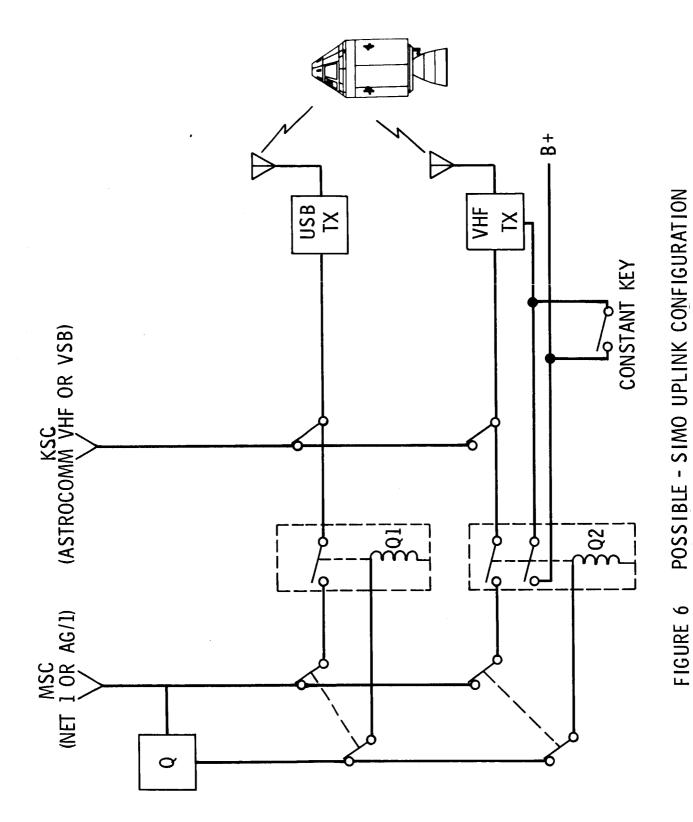
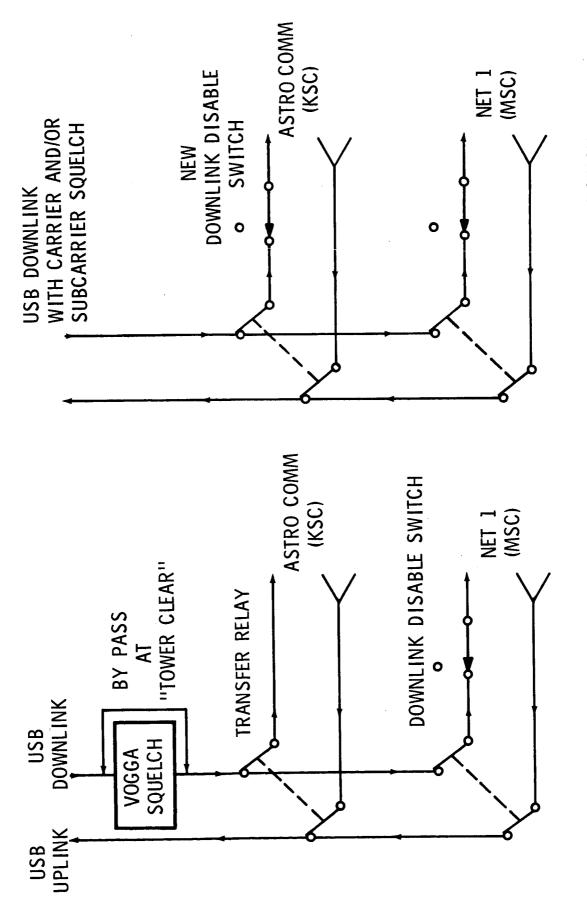


FIGURE 5 CONFIGURATION FOR ELIMINATION OF VOX IN USB UPLINK



POSSIBLE - SIMO UPLINK CONFIGURATION TO ELIMINATE VOX AND LONG LINE NOISE

FIGURE 7 - USB DOWNLINK FUNCTIONAL DISCUSSION



PROPOSED CONFIGURATION

PRESENT CONFIGURATION

# BELLCOMM, INC.

Subject: Review of Voice Operated

Devices in Pre-Launch

Communications at KSC - Case 900

From: J. T. Raleigh

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